Integrating Industry in Project Organized Problem Based Learning for Engineering Educations

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Integrating Industry in Project Organized Problem Based Learning for Engineering Educations

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Abstract

This paper deals with the challenge of establishing engineering student projects in collaboration with industry. Based on empirical results a set of advices for industrial collaboration in project oriented problem based learning are formulated.

Introduction

Project organized Problem Based Learning (PBL) has been an integrated part of the engineering educations at Aalborg University since the University was established in 1974. The project work generally accounts for 50% of the study time. Other 50% is conducted in the forms of lectures, courses, seminars, classroom training, laboratory work and workshops.

At Aalborg University important aspects in engineering education are learning objectives, achieving deeper and more lasting understanding of theory, integration of curriculum elements and outreach objectives involving universities, industry and the public at large. In addition elements as development of communication skills, design skills, team skills and sensitivity to social, environmental and economic factors are important. The team end project based PBL model support these demands.

The idealized problem based learning project work deals with real life problems and most engineering students are highly motivated by projects carried out in collaboration with industrial partners. This paper deals with the challenges of establishing and performing industrial student projects in which the students need to use the theoretical disciplines from the semester curriculum in progress in solving the project problems.

At the same time the collaboration has to be established as a win - win situation to industry and students to secure the possibilities of analogous future projects.

The project work is defined within a semester theme, describing the disciplines to be included. It is supervisor responsibility to ensure the projects include all relevant aspects. The theme description always has to be taken into account when formulating industrial collaboration projects.

At the first semesters the study plans are relatively tighten. All the students have to do project work based on basic theoretical disciplines. As it is difficult to find industrial projects fulfilling these demands most student projects tends to be university formulated laboratory projects using dedicated equipment to illustrate the theories in focus. At the higher semesters there are less specific study plans giving better possibilities for establishing relevant industrial projects. Additionally the students have an extended knowledge at the last semesters.

Motivating factors

Initially all partners in industrial student projects are positive to the idea. Having different goals for the collaboration it is still possible to establish student projects as win – win – win projects to university, students and industry.

Universities

These years there are an intensive political focus on the usability of university activities to the society and especially to the industry implying that it is of particular interest to the university to establish industrial collaboration at all levels of research and education.

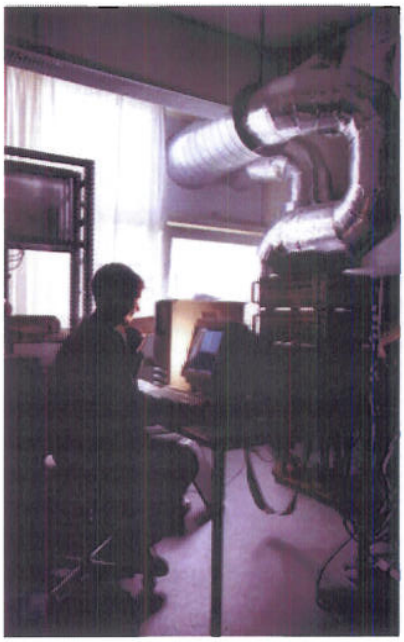
Industrial tasks are seen as an important motivating factor and a great challenge in student projects by most staff members. At the same time it is interpreted as a way to establish contact to industrial partners giving the possibility of future research collaboration. Establishment of research collaboration projects involving a large amount of manpower and financial support can be difficult as a first co-operation. Especially projects involving the university and small companies unused to that kind of projects can benefit from student projects.

Students

Students are very motivated by projects based on real life problems. In addition to the "normal" benefit from project work, the industrial collaboration will give a possibility to take part in solving realistic problems, a deeper knowledge on conditions of employment in industry, typical real-life projects, communication skills, team work and maybe even a part time student job or a job for the vacations.

Industry

The motivations for industrial companies to participate in the formulation and implementation of student projects are differing. Some companies set up project proposals for patriotic reasons. Another reason is that there has been a growing lack of engineers in Denmark and Western Europe during the last decade, implying that companies are motivated to help attracting students to engineering universities and especially to motivate students to specialize in disciplines useful for their own companies. One of the ways to realize this is collaboration with universities, especially to formulate and assist in running student projects.



To obtain a fruitful collaboration between students and industry it is very important to clarify the collaboration conditions to the students and the company and to agree on the expectations. In this paper experiences from very successful as well as less successful collaboration projects are used to set up a generalized list with elements to be taken into account for collaboration projects. Important examples are mentioned below.

Project examples

In the following section examples illustrating different types of collaboration project necessitating different types of agreements are described.

The examples are taken from the control engineering educations. Control engineering is applied in a wide range of applications as consumer electronics e.g. CD-players, in power systems, in plant automation, in motors and pumps etc.

Within the control engineering educations at Aalborg University there is a well established tradition for definition of student projects in collaboration with industrial companies. This type of projects always demands knowledge of the structure of the system in focus as well as of the dynamic behaviour of the system, making real time system data essential to all projects. Data can be the first hurtle. First it can be very important and sensitive to the production while the company might wish it confidential. Secondly it can be difficult to get even though it can be obtained in several ways, either by data acquisition on location or remote data acquisition, by installing a system or a system model in the laboratory or by real time simulation.

Correspondingly it has to be possible to activate the system through actuators.

A Danish food production plant is technically very complex and holds many very interesting tasks from a control point of view. At the same time the company is very co-operative. To be useful for student projects some practical problems has to be solved. The geographic location of the plant imply a 5 hour travelling time each way and due to the growing season the production is only three months a year (October, November and December). The autumn semester at the university is from September 1st until end of January, and the spring semester is from February 1st to the end of June, meaning that it is impossible to get new measurements in the spring semester as there is no production. In the autumn semester all data collections and changes have to be well planed at a very early stage, as the plant staff is very busy during the production period. The first student projects ended up chaotic as all data had to be reconstructed from old plant supervision information.

To overcome these problems the supervisors and the factory staff had to get a good overview and a long term plan. Possible student projects was planed by university staff and factory staff at least a year in advance to secure the necessary data collections in advance. Additionally a real time simulator illustrating the dynamic behaviour of the relevant parts of the plant was developed. To give the students on-location knowledge and the possibility of discussion with plant staff the company was willing to pay the student travel expenses. Taking these initiatives into account the production plant was well suited for student projects during several semesters in the automation education.

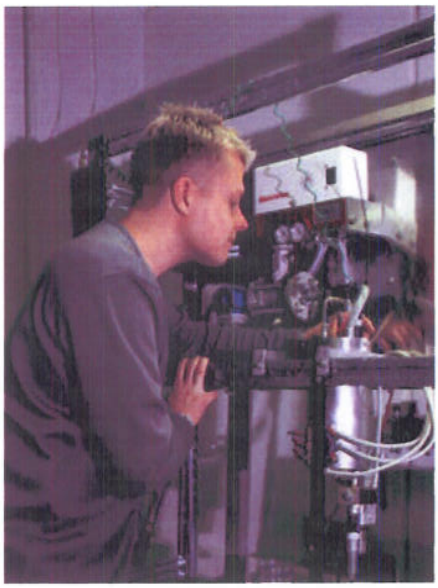
Small upcoming companies often rely on a very specific idea. A major area of concern is to loose the idea to competing manufacturer. In many cases the company expertise is not covering all aspects of the product or production and they need solutions within a short period. What they really need is consultancy work as cheap as possible. In such cases it is very important to make it clear that student projects don't guarantee a result and doesn't comprise product maturing.

An example is an upcoming communication company. The formulated project involved equipment very important to future success for the company implying strict confidential requirements.

To run this project, it had to be made clear to the company that the university basically is an open environment. In this case it turned up to be a problem as it was relevant and convenient to place company equipment at the university. Laboratories are not public, but many students and staff have access. The solution was to place the equipment in a locked laboratory, making it clear that it couldn't be guaranteed that anybody from outside would get access. Another problem was the students' final report. It is basically public, but it is possible to make parts of a report confidential. The students were asked to sign a declaration of confidentiality, but the university strongly advised them not to sign a competition clause.

Some of the very large Danish industrial companies have learned how to handle student projects. They are formulating a wide range of projects. Most of them are very easy to handle. The projects are formulated to fit into the study plans, the companies support with necessary equipment and data. Additionally they let the students visit the production plants and make staff disposal when necessary. The purpose for these projects can be to develop and test ideas and principles for future use making the company independent of short term results.

According to the above mentioned circumstances it could appear to be very problematic to establish good and successful student projects in collaboration with industrial partners. That is not the case. The examples illustrate problems in the establishment of the first collaboration projects. Later some general considerations has been taken into account and every case ended up with very successful projects. One of the lessons learned is, that it is very important that the supervisor carefully evaluate the project ideas before startup.



These examples illustrate different types of industrial student projects giving different advantages and disadvantages. Empirical results from the examples and other projects show that industrial involvement in student projects in general are very positive but it need to be well planed and arranged to be successful. In the next section some of the issues are enhanced.

Guidelines for development of industrial projects

When the university was established 30 years ago the staff had to do a lot of field work to find relevant industrial projects, IPR almost always accrued to the company. Now it is the opposite way round. The companies turn to the university and they pay parts of the expenses. IPR is shared between the company, the students and maybe the supervisor. Still the supervisors have to evaluate the proposals carefully due to the possible use of the theoretical disciplines in the semester theme, the availability of necessary equipment, information etc.

In this section identified rules of thumb for god collaboration projects are pinpointed.

Student project definition

The first thing to handle is defining a student project to the company and the students. It is important to clarify the expectations to the partners. It has to be made clear to the companies that student projects are different from consultant engineers. Student's projects have to fulfill the study program; the project reports in general are public and as a minimum it has to be read by a censor. Given some of the data are confidential it is possible to split the report in two parts a public part and a confidential part.The curriculum describes demands for the disciplines to be handled which is more important than company relevant results.

In the best case the company can benefit from investigation of solutions to long term tasks within the company or from the solutions as a kind of prototyping. Projects can't be used for final product development.

Even though the companies have to spend time and maybe money and equipment student projects don't necessarily lead to a solution to a present problem. Though given the company has staff acting as sparring partners it can benefit from student attention and knowledge of the company, future engineers with specialisations within the area of the company and easy aces to university staff for instance for research results and advices to company problems.

A subsequent problem could be that new ideas as well as facts on efficiency and similar matters must be released if relevant to the agreed project.

Another important issue is to make a realistic estimate on the performance level of the company– preferably a timing of necessary assistance.

Companies have to realize that participating can be an extra strain to busy staff. During a project period the company has to be supportive due to competent staff – not necessarily engineers, plant operators with a detailed knowledge of the production are also relevant. In a similar way it has to be clear to the students that confidence and respect to working conditions and production within the companies are very important. Data acquisitions and tests must be planed and pre-agreed with company staff in detail. At the same time the students have to be aware of that deals tends to be broken in busy periods in the company.

Student projects are not a consultancy assignment giving a guarantied solution. In student projects students supported by a supervisor are working at the tasks for a semester; there are no guarantees for the result but always the advantage of outside ideas to the solution of relevant tasks. Usually the student commitment and result is related to the company commitment.

The project proposal needs to be well prepared before the semester start-up which can be a time consuming process. It is necessary to inform the company that even though the project proposals are well planed it is not necessarily chosen by the students.

Economical aspects

Other important issues are to make an agreement on all economical aspects of the project and to make an agreement on legal property rights IPR.

Concerning direct costs, it must be made very clear to the company that participating involve expenses. Staff has to participate in project meetings; most engineering projects necessitate aces to data and equipment and an agreement on the responsibility for equipment to be operational is needed.

In general the data will need to illustrate the dynamic behavior of the system. It has to be realized that such measurements can be difficult and expensive to obtain and sometimes it can catch out company secrets. There is a big difference in the usability of on-line and off-line data measurements; the students must know what will be available. Data can be directly accessible, but in many cases it is necessary to disturb a steady state stability to gain information on system dynamics. In sensitive plants this type of intervention is undesirable.

Given data acquisition and tests are performed in the plant a project often requires equipment added in the plant. Alternatives are to build a physical model in the university laboratory or to develop a real time simulator illustrating the dynamic behaviour of the plant. In general the university will not be paying for equipment to be placed permanently in a plant. Equipment can be lent out from company to university or visa versa. A typical solution is that companies are paying for data acquisition equipment, parts produced by the company and sometimes for physical models.

The geographic location can be another hurdle, but can be handled by payment of travel expenses.

IPR

Legal property rights (IPR) are an important issue in most collaboration projects. Given the invention is part of a product the company often are interested in protection for further development. The patents are taken out mainly to prevent rival companies in blocking further development. IPR can be shared. One way to handle it is to give the IPR for applications related to the specific plant or production to the company and the rights for the methods used in other application areas to the students and the university.

In projects resulting in new products the IPR typically are shared between the company, the students, the supervisor and the university.

Benefits from industrial student projects

University contact gives companies the possibility of research related projects. The students and staff will gather knowledge on the company and related problems can be incorporated in the curriculum. At the same time it will help in attracting people to the area.

Real life problems motivate students to work harder, sometimes they use al the spare time doing project work. The project can be launch pad for future collaboration and the students get grounding in the business basics. Another possibility for students to obtain industrial experience could be work experiences programs. In these programs the primary problem is to ensure that the student get relevant experiences and not is used as cheap labour whereas project work ensure the relevance to the student.

Summary

This paper has illustrated some of the issues to be taken into account to obtain successful student projects in collaboration with industrial companies.

The results are based on empirical results from a wide range of student projects. Selected examples are used to illustrate some typical characteristics of these projects.

The most important issues to be handled in advance is legal property rights, student aces to data and equipment, financing of additional equipment, travel expenses etc.

Taking all these issues into account industrial related projects is very successful in the area of student motivation, student commitment, students' industrial experience and university relation to industry at all levels.